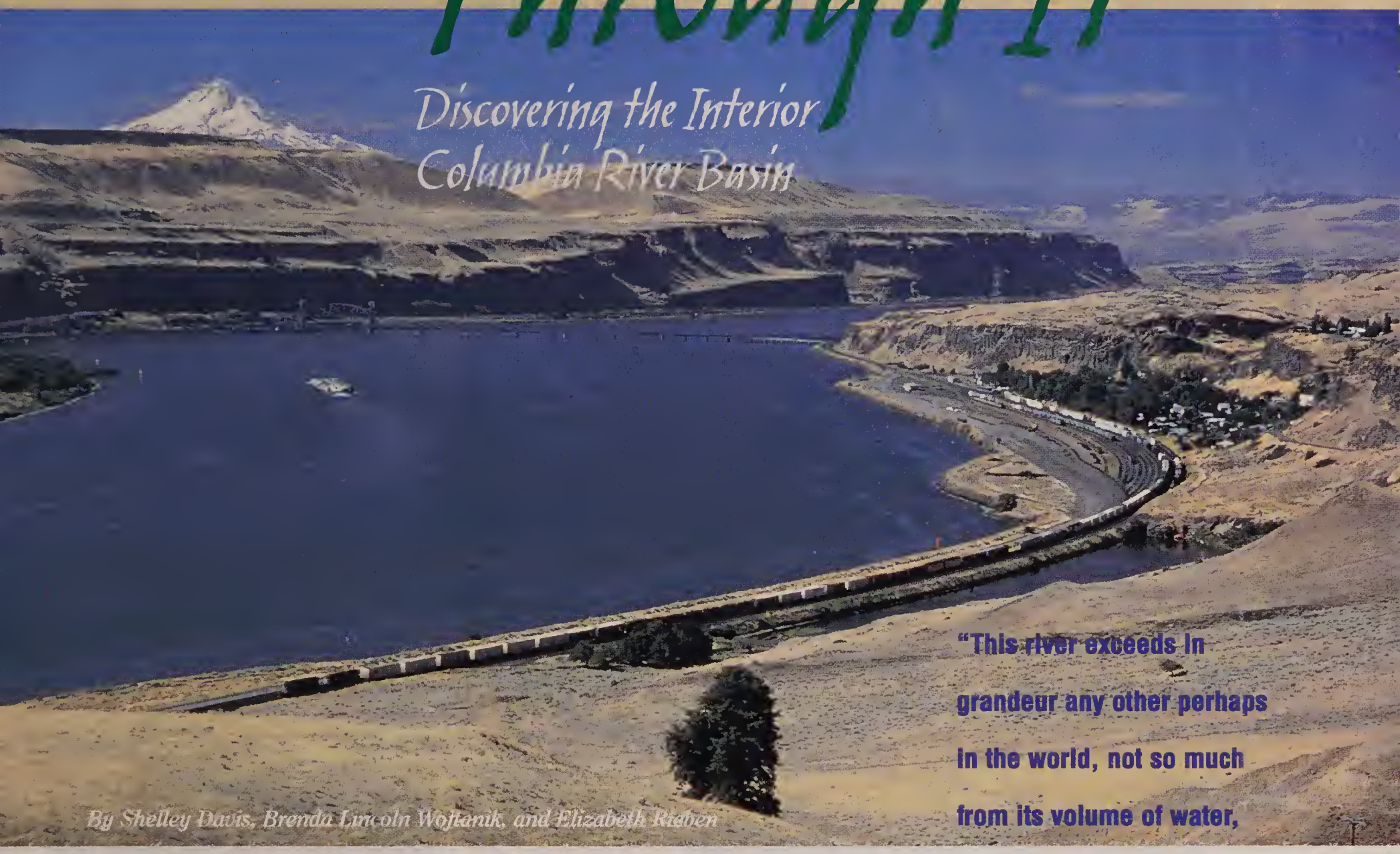
Rivers Run Through It

Discovering the Interior Columbia River Basin



By Shelley Davis, Brenda Lincoln Woltanik, and Elizabeth Rieben

The Columbia River is the sculptor that carved the Interior Columbia River Basin from the landscape of seven Western states and two Canadian provinces. To Native Americans, explorers, and emigrants, the river represented the lifeblood of this land of promise and plenty. But the land also presented hardship and danger with mountain ranges climbing to over 3,900 m and harsh deserts and scablands scoured clean of productive soils by glaciers and floods.

People have been drawn to the big and beautiful Columbia River Basin for thousands of years. During the last century, natural resource–based industries supported small, growing communities. Today, people still appreciate the basin's rural flavor and quality of life. Yet the area remains sparsely populated, containing 8 percent of the land area in the United States, but only 1.2 percent of the population.

This article explores the story of this land, its many ecosystems, and the challenges faced by natural resource managers. By studying the basin's diversity and complexity, students can learn about common scientific concepts such as the power of water and effects of rain shadows. They can also explore complex social-scientific issues such as conflicts between protecting historic salmon runs and providing inexpensive electricity through hydropower or the reintroduction of top predators, such as the grizzly bear and gray wolf, into the ecosystem.

"This river exceeds in grandeur any other perhaps in the world, not so much from its volume of water, although that is immense, as from the romantic wildness of its stupendous and ever-varying surrounding scenery, now towering into snow-capped mountains thousands of feet high, and now sinking in undulating terraces to the level of its pellucid waters."

—Paul Kane, Northwest explorer and artist, 1847

Geology and Climate

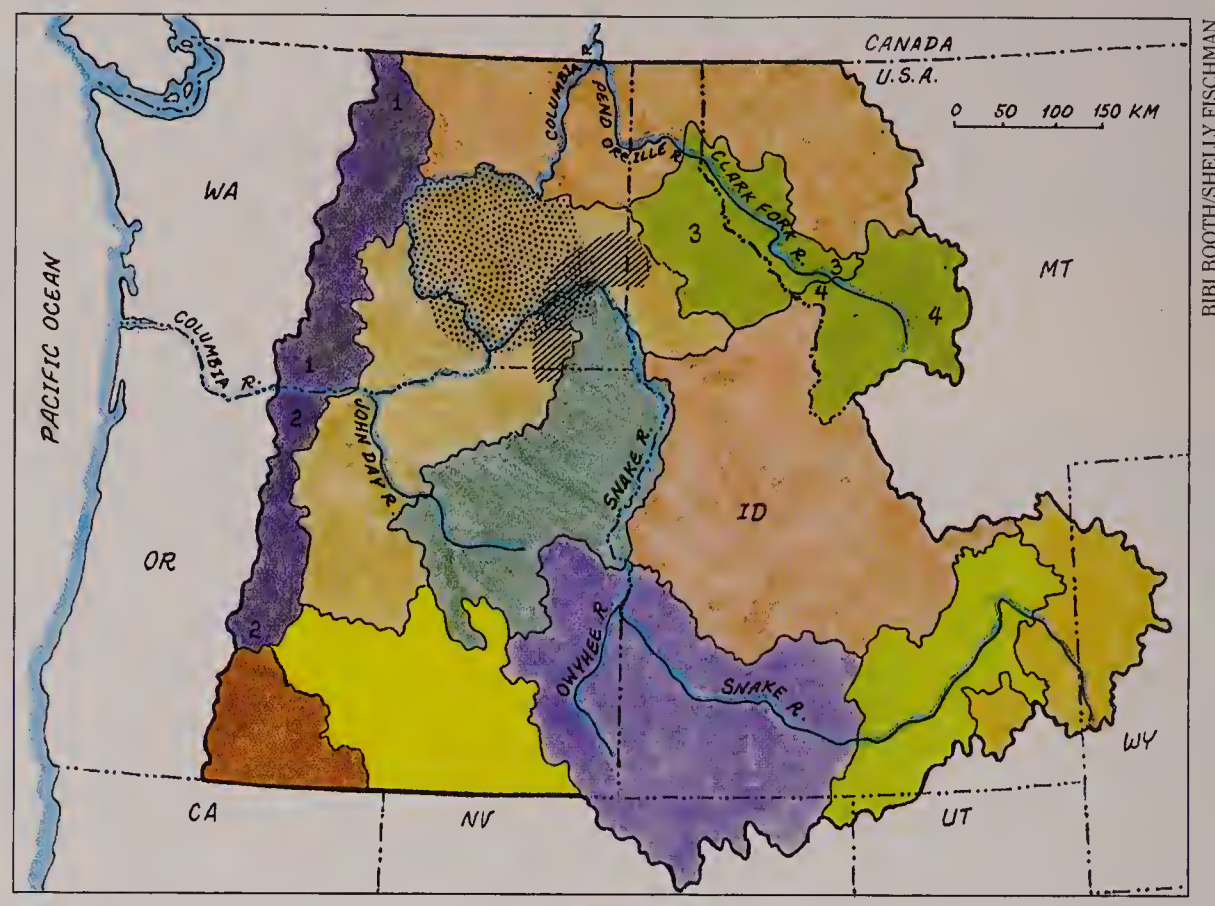
The Columbia River drops more than 735 m from its headwaters in British Columbia, winding over 1,950 km to the Pacific Ocean. Although the river itself flows from Canada through only two states, forming part of the Washington-Oregon border, the vast Interior Columbia River Basin is defined by the area drained by the river and its many tributaries. This 58-million-hectare area (about the size of France) extends roughly from the crest of the Cascade Mountains of Oregon and Washington east through Idaho to the Continental Divide in the Rocky Mountains of Montana and Wyoming, and from the headwaters of the Columbia River in Canada to the high desert of northern Nevada and northwestern Utah.

The Columbia River Basin is a complex tapestry of mountains, high plateaus, desert basins, river valleys, rolling uplands, and deep gorges woven together by the Columbia River and its tributaries.

Mountains are a major and dramatic presence in the Columbia River Basin. There are a number of mountain ranges in the basin, including the volcanic Cascades forming the western border and the Rocky Mountains on the basin's eastern border.

South and east of the Cascades are the Klamath Uplands, which support lodgepole pine and juniper forests. The Columbia Plateau ecosystem, an old basaltic lava field, consists of a variety of grasses and shrubs. The remote Owyhee Uplands include mountains and a rolling plateau transected by deep canyons and covered by sagebrush, bunchgrasses, and junipers. The upper Snake River floodplain supports cottonwoods and grasses. Irrigated croplands dominate many valleys, plateaus, and uplands. The northern reaches of the arid Great Basin ecosystem consist of sagebrush, bitterbrush, and rabbitbrush at lower elevations.

Much of the basin experiences the rain shadow effect of the north-south mountain ranges that block moist winds from the Pacific Ocean. As the air rises, it cools, losing ability to retain moisture. Rain and snow fall on the western side, while lands east of the mountains remain arid. Rain shadows are particularly evident where major mountain ranges are perpendicular to the direction of prevailing winds and storm tracks coming from the ocean, as with the Cascades. One of the most dramatic climate changes occurs here where the lush, moist old-growth forests on the western side give way to an arid shrub-steppe environment on the eastern side. Climate varies greatly throughout the basin, depending upon elevations ranging from just above sea level to over 3,900 m. Annual precipitation can vary from about 25 cm to 250 cm.



BIBI BOOTH/SHELLY FISCHMAN

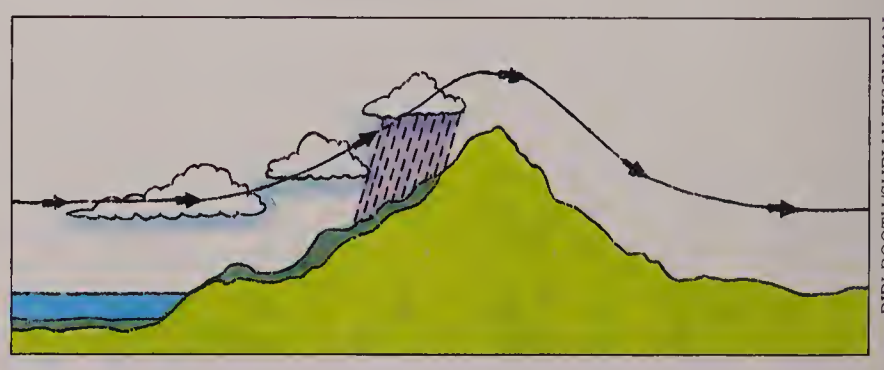
A common feature of the Columbia River Basin is the shrub-steppe ecosystem where moisture is scarce (coming mostly from snow in winter), the wind is persistent, and temperatures vary from 38°C in summer to well below freezing in winter.

Big sagebrush is especially adapted to survive these conditions. Its root structure can reach as far as 27 m in diameter, dominating the water source and limiting the number of other large plants that can establish themselves. Its small gray-green leaves are covered with minute white hairs that keep water in the plant. In this harsh climate, sagebrush provides important cover and forage for wildlife.


DON SMURTHWAITE, BLM

Sagebrush-steppe habitat in southwest Idaho at the foothills of the Owyhee Mountains. Wildlife use the sagebrush community at different times of the year for different purposes. Sage grouse eat sagebrush leaves in winter. Golden eagles actively hunt the black-tailed jack rabbit. Mule deer use the shrubs to hide from predators and rear their young.

The Rain Shadow Effect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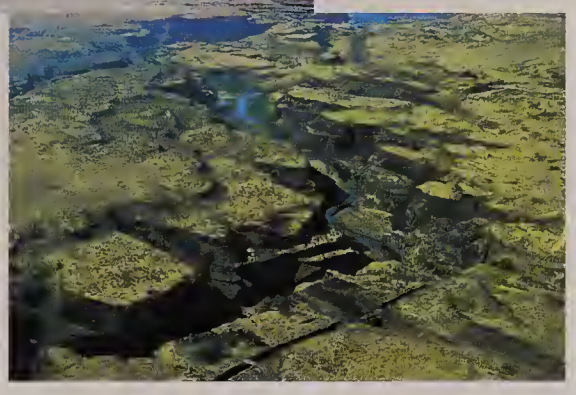
LARRY RIDENHOUR, BLM

The largest tributary of the Columbia River is the Snake River, flowing from its headwaters in Yellowstone National Park in western Wyoming for over 1,670 km through Idaho, Oregon, and Washington. Here, on the Oregon and Idaho border, the Snake River carved the 2,370 m Hell's Canyon, the deepest gorge in North America.



NATIONAL PARK SERVICE

The Palouse River carved this canyon through layers of ancient lava flows on the Columbia Plateau in eastern Washington.

LARRY RIDENHOUR, BLM

Forbs such as arrowleaf balsamroot are part of the sagebrush community.

BARRY ROSE, BLM

Another plant suited to the sagebrush community is Indian paintbrush. A semi-parasitic plant, its roots penetrate the roots of other plants, such as sagebrush, to steal nutrients.

Accompanying sagebrush in the community are a variety of native plants such as rabbitbrush, bitterbrush, greasewood, winterfat, spiny hopsage, horsebrush, fescue, Indian ricegrass, bluebunch wheatgrass, and wildrye. Other herbaceous plants, or forbs, include lupines, globe mallow, Indian paintbrush, sego lilies, phlox, and arrowleaf balsamroot. An occasional prickly pear cactus can also be found.

Fish and Wildlife

The Columbia Basin's deserts, forests, rivers, and rangelands provide integral habitat for 609 known fish and wildlife species, including some of the most rare and endangered species in North America: bull trout and sockeye salmon in the rivers of Oregon, Washington, and Idaho; bald eagles and vesper sparrows throughout the basin; gray wolves, grizzly bears, and even the elusive Canada lynx in remote areas of Idaho and northwestern Montana.

Close to 3,800 invertebrate species have been identified in the basin, but an estimated 20,000 more—including various species of ants, spiders, and butterflies—are yet to be described. Millions of migratory birds rest and feed in various wetlands and forests within the basin. The Snake River Birds of Prey area near Boise, Idaho, harbors the densest nesting concentration of birds of prey in North America, including more than 800 pairs of eagles, falcons, hawks, owls, and other raptors.

Oasis in the Desert

One of the premier birdwatching sites in the United States is found in an unlikely spot—the remote high desert of Harney Basin in southeastern Oregon. Here, snowpack from the Steens Mountains drains into a complex system of landlocked lakes, marshes, and waterways at the Malheur National Wildlife Refuge. These wetlands attract thousands of migratory birds each year, representing over 300 species.

A. LYNN BURTON, USFS

Magnificent bighorn sheep can be seen in the Hell's Canyon area.

Another unlikely haven for wildlife is the Hanford Reach in eastern Washington. Here, on the last free-flowing stretch of the Columbia River, elk, salmon, and a variety of other wildlife find refuge in the noncontaminated buffer zones of a closed plutonium factory that has left massive radioactive wastes in some areas. A stretch of the river is proposed for wild and scenic designation, and parts of the area are under consideration for addition to the national wildlife refuge system.

A. LYNN BURTON, USFS

The varied wildlife and good fishing attract people to the Columbia River Basin.

A. LYNN BURTON, USFS

Muskrats, and people, are naturally attracted to water.

BETH ULLENBERG, USFWS

The wetlands of Malheur National Wildlife Refuge in arid southeastern Oregon make this a favorite stopover and feeding site for birds.

Anadromous Fish

Few things link the Columbia Basin like anadromous fish. These fish reproduce and rear in fresh water, then migrate downriver to the ocean. As adults, they return to the streams and rivers where they hatched to start the cycle over again. Some anadromous fish travel over 1,440 km on this journey, returning to the exact location where they hatched.

Within the basin, there are six species and subspecies of fish whose habitats span from the waters of the Pacific Ocean to the mountains of the Continental Divide bordering Idaho and Montana. These are fall, spring, and summer chinook salmon; sockeye and coho salmon; and steelhead trout. Salmon are considered keystone species, supporting all others in the basin. Salmon contribute nutrients to streams that, in turn, support other aquatic and terrestrial species. Without salmon, the ecosystem "unravels."

For example, in Idaho's Redfish Lake—named for the red sockeye salmon that provided color to the lake during spawning season—sockeye salmon seldom return to spawn and die. Much-needed algae and zooplankton formerly generated by decomposing salmon carcasses are gone from the lake, limiting the food source for young sockeye. This lack of nutrients also affects bull trout, Westslope cutthroat trout, sculpins, suckers, clams, and mussels. On the banks, river otters have to find other food sources, as do bears and eagles. Birds of prey, especially osprey, have been moving away from streams and rivers to find food.

For thousands of years, salmon have played an important cultural role for the people in the Columbia River Basin, not only as a keystone species and food source, but also because of their awe-inspiring life cycle. As a result, restoring historic salmon runs has been a driving force behind many recent management initiatives in the basin.

Management Challenges

Just as salmon cross jurisdictional boundaries, so do many of the issues faced by land managers in the basin. The spread of weeds, wildland fires, disease spores, stream silt, and air pollution, as well as the loss of migratory bird habitat, all clearly cross land-ownership boundaries.

To ensure these issues are adequately addressed, federal agencies are working together to develop a scientifically sound ecosystem-based strategy for managing 28 million hectares of public lands in the Interior Columbia River Basin. This far-reaching effort, the Interior Columbia Basin Ecosystem Management Project, seeks to restore and maintain healthy ecosystems and support the economic, social, and cultural needs of people and communities.

The project's first step was to conduct an unprecedented study of the entire area. The result was *The Integrated Scientific Assessment for Ecosystem Management in the Interior Columbia Basin and Portions of the Klamath and Great Basins*, published in September 1996. This comprehensive scientific analysis involved scientists and technicians from federal and state agencies, universities, and private contractors who examined changing conditions in the basin over the last 100 years. They confirmed that the Columbia River Basin has undergone dramatic ecological changes as the region has been settled and developed.

Changing Landscapes

A hundred years ago, the basin featured large, widely spaced, sun-loving trees. Frequent, light fires cleared competing vegetation. Plant and animal species migrated freely through large blocks of habitat. Over the last century, harvesting of large old-growth trees resulted in forests with smaller, densely grown, shade-tolerant trees. As trees became crowded, increased competition for water and nutrients made them susceptible to damage from insects and diseases. In addition, historic suppression of fire allowed shade-tolerant species to fill the understory. This provided a fuel ladder to the taller trees, increasing the likelihood that wildland fires would be severe and costly.

The Bureau of Land Management (BLM) and the U.S. Forest Service are now using prescribed (carefully managed) burning to reintroduce fire into the ecosystem in order to avoid catastrophic wildland fires. They also are experimenting with ways to use forest thinning and various timber harvest techniques to reduce fuel loads.

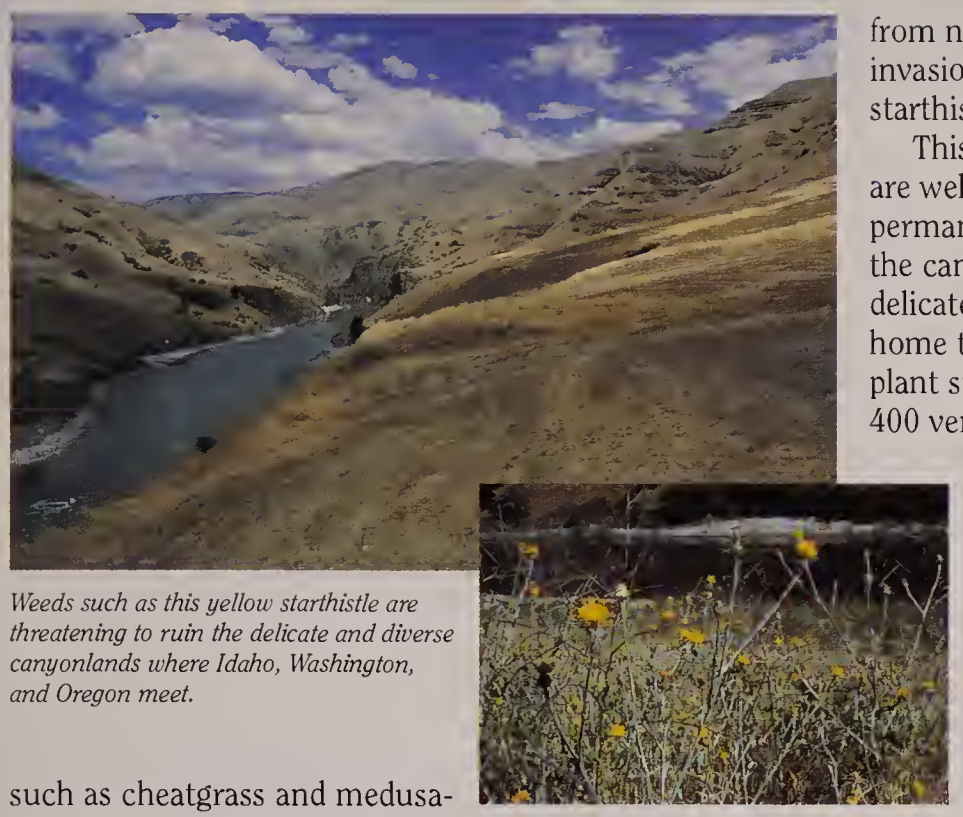
Wildland fires also historically cleared organic debris from the rangelands, killed nonsprouting species such as sagebrush, and stimulated regrowth of sprouting shrubs and grasses. However, roads and agricultural lands stopped the spread of fire, and people suppressed fires whenever they could. As a result, fire frequency decreased. The lack of fire has allowed woody species such as juniper to encroach upon native perennial grasses and forbs.

In addition, heavy grazing by livestock at the turn of the century significantly altered rangeland plants. Overgrazing of riparian (streamside) areas resulted in unstable streambanks, increased stream sedimentation, and reduced some areas' ability to capture and store water. Undesirable nonnative species of plants

DAVID NOLTE, TROUT UNLIMITED

Culver Middle School students assist in fish surveys in the Crooked River watershed in eastern Oregon.

ELIZABETH RIEBEN



Weeds such as this yellow starthistle are threatening to ruin the delicate and diverse canyonlands where Idaho, Washington, and Oregon meet.

such as cheatgrass and medusahead rye have invaded sagebrush ecosystems, outcompeting native grasses and forbs and reducing forage and cover for wildlife and livestock. The reduction in native species has created a more simplified and less resilient rangeland ecosystem.

Local ranchers, environmental organizations, and government agencies are working together to reverse these trends. In the Trout Creek Mountains in southeastern Oregon, for example, these partners altered grazing practices to repair damage caused by more than 100 years of season-long grazing. Their efforts are leading to ecosystem improvements, most notably measured by an increase in threatened Lahontan cutthroat trout inhabiting associated streams.

Nonnative Weed Invasions

The spread of invasive, nonnative (exotic) plants is causing severe damage to entire ecosystems in the Columbia River Basin. In addition to cheatgrass and medusahead rye, leafy spurge, spotted knapweed, rush skeletonweed, and yellow starthistle are spreading rapidly into rangelands, forestlands, recreation areas, roadsides, and waterways in eastern Oregon, eastern Washington, western Montana, and Idaho.

BLM Weed Demonstration Areas within the basin demonstrate how people can work cooperatively to prevent and control weeds. For example, where Idaho, Oregon, and Washington meet just north of the famous Hell's Canyon, a community team representing state and local government as well as private industry worked side-by-side to map and inventory over 8,000 hectares that were highly susceptible to broad-scale degradation from nearby massive invasions of yellow starthistle.

This and other weeds are well on their way to permanently degrading the canyon landscape, a delicate and wild system home to at least 24 rare plant species and over 400 vertebrates, including mule deer, bighorn sheep, and golden eagles. The team is implementing control methods, such as hand pulling and herbicide spraying, but the job is so large that unless all landowners join in, and unless the spread of these infestations into new areas is prevented, weed control efforts ultimately will fail.

Aquatic Ecosystems

The health of aquatic ecosystems is critical to the entire Columbia River Basin. About 80 percent of all fish and wildlife in the basin use the riparian (streamside) habitat at one time or another. Timber harvesting, livestock grazing, road construction, and mining have all dramatically changed aquatic ecosystems, affecting both water quality and quantity and altering water flows and temperatures. This, in turn, affects the types of wildlife, fish, and plants that can survive in the area.

Salmon and other fish need aquatic habitat areas that are shaded and cooled by trees and protected with undercut banks vegetated by healthy grasses and sedges. The water should have plenty of woody debris where fish can hide and rest, as well as plenty of aquatic insects to eat.

Not surprisingly, relatively untouched streams within wilderness or roadless areas tend to have the healthiest aquatic habitat conditions in the basin. Central Idaho retains some of the highest-quality fish habitat due to its remoteness and high elevation. Few anadromous fish can take advantage of these habitats, however, because fish passage is impeded by over 450 large dams, as well as many smaller ones, in the basin.

Dams restrict the migration of anadromous fish species, blocking them from important habitats and increasing mortality of juvenile salmon traveling downstream. Some of these dams have fish passage facilities, but many smaller dams do not. Turbines kill juvenile fish. Dams also cause migrating fish to spend more time in slower and warmer waters created by reservoirs. Physiological stress and increased susceptibility to predators result as fish congregate in smaller areas.

Public and private water managers are working to increase the survival of these fish by increasing water flows during certain times of the year to help fish travel over the dams, installing fish ladders to guide fish around the spillways, and hauling juvenile fish around dams in trucks or barges. Despite these efforts, however, dams still pose the greatest threat to the survival of native salmon and trout runs in the Columbia River Basin.

Loss and fragmentation of diverse habitat have also contributed to a decline in native fish diversity. Many salmon species inhabit a small portion of their former ranges, while many introduced nonnative species, including recreational species such as bass and brook trout, are widespread. Of 87 native fishes in the basin, 45 are recognized by state and federal management agencies as sensitive or species of special concern. Twelve species are either listed or candidates for listing under the Endangered Species Act, including bull trout and steelhead.

BLM PHOTO, SALEM, OREGON

Streams and rivers of the Columbia River Basin once were "freeways" for millions of salmon returning each year to spawn. Today, only about 10 percent of these fish have survived. At least 67 distinct salmon runs are gone and many more are at risk.

Aquatic Restoration Efforts

Local communities, including schools, are working with land managers on a number of aggressive aquatic habitat restoration efforts throughout the Columbia River Basin.

In central Oregon, for example, two teachers are involving students with ongoing watershed restoration efforts on the Crooked River, which winds through the Ochoco Mountains and the Columbia Plateau. With community support and financial assistance from organizations

DAVID NOLTE, TROUT UNLIMITED

Older students teach younger students about watershed restoration at the "Fish Fest," part of the Crooked River Ecosystem Education Project in Oregon.

such as Bring Back the Natives, a national public/private initiative to restore native aquatic species, the teachers created a watershed-level environmental education program for K–12 students in two school districts. The program draws on local experts who offer technical and financial assistance. In return, students provide the community with watershed restoration work and research. High school students have completed sediment studies, habitat surveys, and wild fish monitoring projects. Students also work on stream restoration and riparian plantings through a special greenhouse program to propagate cottonwood trees.

Youth from five Native American tribes also are working to restore salmon populations in the basin as part of Salmon Corps, a program sponsored by the Earth Conservation Corps involving 100 Americorps participants in Oregon, Washington, and Idaho. These young adults representing the Yakama Nation, Confederated Tribes of the Umatilla Reservation, Nez Perce Tribe, the Confederated Tribes of Warm Springs, and the Shoshone-Bannock Tribes are restoring 400 km of streambed and erecting 480 km of cattle-exclusion fences to enhance 29 salmon habitat areas.

LARRY RIDENHOUR, BLM

JACK A. SEELEY

Populations of grassland and shrub-steppe species, such as sage grouse and pronghorn, are declining due to loss of habitat.

Habitat Loss in Grasslands and Forests

The loss of steppe habitat (areas receiving less than 30 cm of rain per year) in the Columbia River Basin is having a detrimental effect on wildlife. Populations of both grassland and shrub-steppe species such as the sage grouse, Columbian sharp-tailed grouse, sagebrush vole, upland sandpiper, grasshopper sparrow, and pronghorn are declining throughout the basin. In eastern Washington, the BLM and the Washington Department of Fish and Wildlife are working together to assist upland species such as sharptail and sage grouse by exchanging land with private landowners to acquire steppe habitats in large blocks. Much of the native steppe habitat has been converted for agricultural purposes. By exchanging isolated forested tracts and purchasing larger blocks of meadow steppe lands, the agencies hope to provide a safety net of habitat.

In the basin's forests, populations of cavity dwellers, including several species of owl, woodpeckers, and the northern flying squirrel, are declining due to fewer dead or dying trees. In areas near roads, fallen trees are often collected for firewood or other uses. Roads also pose other risks to wildlife. Many animals have been killed crossing busy roads and highways.

Neotropical migratory birds traveling between North and South America each year also have fewer and fewer safe stopover areas. Habitat is also an issue for the federally protected grizzly bear and gray wolf, which require large, uninhabited areas. Their needs and the needs of people living near them must be carefully weighed in planning for their recovery.

A New Management Approach

The *Scientific Assessment* confirmed that rangeland, aquatic, and forest health issues are intricately connected in the Columbia River Basin. Scientists concluded that any proposed management strategy must also link these issues across boundary lines and agency jurisdictions.

A proposed strategy is described in two draft environmental impact statements released in June 1997. It calls for aggressive restoration of forests, rangelands, and watersheds. It emphasizes forest thinning and using prescribed fires during cooler seasons to decrease risks of large, severe wildland fires. It also calls for increased efforts to stem the tide of invasive weeds. The proposed strategy recognizes that people who live in the basin have a stake in its management—many make their living from its rich natural resources. Although most of the basin is rural, several urban centers are among the fastest growing in the country. In addition, a number of Native American tribes and other traditional communities have interests in lands within the basin.

Monitoring watershed conditions at many different scales will be a key to measuring progress as National Forests and BLM Districts in the Columbia River Basin begin to implement this plan. Monitoring tools include looking at changes in water quality and quantity, streamside vegetation, extent of weed invasions, native fish and wildlife populations, and numbers and sizes of severe wildland fires. But the ultimate measure of success will be known many years from now, when people living in the basin continue to enjoy a high quality of life, sustained by the basin's rich natural resources. With their involvement and support, federal, state, and private scientists and land managers hope to restore ecological health to the basin so future generations will continue to be captured and enraptured by its wild beauty.

LARRY RIDENHOUR, BLM

Spiny hopsage, a native shrub of the salt desert, grows on the alkaline flats of the Snake River Canyon near Boise, Idaho. American Indians ground parched spiny hopsage seeds to make pinole flour. It also provides forage for livestock and big game.

SANDY FELSENTHAL/NATIONAL GEOGRAPHIC IMAGE COLLECTION

The rolling, fertile Palouse Hills in eastern Washington are composed of deep loessial (wind deposited) soils. Much of the nation's wheat is grown here.

All Shapes and Sizes

To get a complete picture of a region, scientists analyze it as a whole in addition to analyzing its component parts on a more detailed level. In the Columbia River Basin, scientists may study a particular watershed or various vegetation types such as forests and rangelands at different elevations. Social and economic aspects of the basin are also considered.

This activity will help students describe the differences in a landscape or environment seen at various distances and give reasons to look at a landscape or environment in several different ways and with several different objectives in mind.

Materials: Select a foldout (such as the one included with this article) with a scene that has considerable detail. The foldout should be new to the students. It is best if the subject or theme of the foldout is not readily apparent until the students get closer. You will also need a measuring tape and masking tape.

Procedure: Hang the foldout at one end of a large room. Measure 15 m from the foldout and mark the floor with tape. Then measure and mark the floor at 3 m intervals coming toward the foldout. Repeat the markings three or four times to form an arc.

Align the students single-file along the outermost edge of the arc (15 m). Give the students about 30 seconds to 1 minute to observe the foldout and write a description of what they see from this distance. Ask students not to share this information. Next, advance the students together to the next arc (12 m) and repeat for each successive distance.

When the students arrive at the closest mark, allow small groups (five or six students) to advance slowly until they can get their nose on the foldout and record their observations at this point. After all students have completed the activity, ask the following questions: What did the students see at the farthest point? Did the images look different as they got closer to the foldout? What did they learn at different distances? How much of the foldout could they see when their nose was on it? How is this picture different from the one they saw at a distance? At what point did they learn the most about the subject of the poster? How was their perspective enhanced or limited by each stop? How does this apply to the land use planning efforts being undertaken in the Interior Columbia Basin or in other areas? (Managers plan on a site-specific level but also are looking at the bigger picture through regional, ecosystem-based planning.)

Watersheds All Around

Generally, watersheds are described as the land that drains water from an area into its waterways such as streams and rivers. Watersheds are important physical features of the Interior Columbia Basin. The *Scientific Analysis* identified 2,500 watersheds in the basin. Watersheds can be large or small, draining a single valley or the entire basin. In this activity, students explore what a watershed is and how it works.

Materials: For this activity, you will need various sizes of rocks, a shallow plastic wash basin or tub (about 30x45 cm and 25 cm deep), heavy paper or a plastic tarp, a permanent marker, and a sprinkling can or spray bottle (to simulate rain).

Procedure: Place some rocks in the wash basin to build mountains and valleys. Cover with heavy paper or a plastic tarp. Ask the students to guess the route "rainwater" (from the sprinkling can or spray bottle) will take and where it will pool and be stored. Mark the predicted route with a permanent marker. Then test the students' predictions by spraying or sprinkling the area and observing the path of the water.

Watersheds are divided by areas of high elevation. When rain lands on the ground, it travels downhill to be drained. If water hit a mountaintop or ridgetop in the model and traveled in more than one direction, it is likely that there was more than one watershed. Most aquatic species, such as fish, do not cross watershed divides. How many watersheds did the students find in the model?

A healthy watershed not only stores but also filters water for a river or stream. When water hits the Earth and percolates through the soil into the water table, soil, rocks, and sand filter out many of the impurities carried by the water. To see how this might work, try the following activity.

Materials: You will need a flower pot with a drainage hole; a few cotton balls; some sand, soil, and gravel; and some muddy water.

Procedure: Plug the hole in the flower pot with cotton balls to represent subsoil, and fill the pot with a mixture of the sand, soil, and gravel. Slowly pour some muddy water into the pot and observe. The water running out of the drainage hole will be relatively clean.

Watershed Scavenger Hunt

After discussing watersheds in the classroom, take students outdoors to see if they can spot signs of watersheds on the school grounds or in a nearby park. Begin by asking students where they think water will drain on the school grounds. Ask what clues they think they will find to help them identify a watershed.

DON SMURTHWAITE, BLM

Small streams from the Sawtooth Mountains (in the background) drain into Stanley Lake in Idaho.

Divide the class into groups of three, and send them outside to find the following items: a damp spot that might collect water; a stream of water and its tribu-

taries; a gully created by water; a sign of erosion; a structure that would block or change the flow of water; and a place where water might be filtered. Back in the classroom, compare results and draw a map of the watersheds the students observed.

Renewable and Nonrenewable Energy

Hydropower is a renewable form of energy—electricity produced from the energy of falling water. The supply comes from a natural event that will never run out—in this case, the hydrologic cycle. Other forms of renewable energy are wind farms (see "The High Plains: Land of Extremes," *Science and Children,* September 1996), and solar power. Nonrenewable energy, such as coal, oil, and gas, is available in only a finite supply.

Write the two headings *Renewable* and *Nonrenewable* on the blackboard. Have students list energy types (hydropower, solar, wind, natural gas, oil, coal, nuclear, geothermal, and so on) under each heading. Discuss the costs and benefits of each type. Costs should include environmental costs as well—such as declining salmon populations due to hydropower.

Introduce the concept of energy conservation. Why is it important to conserve nonrenewable energy? (Because it will run out eventually.) Are there reasons to conserve renewable energy? (All energy generation has environmental impacts. Conserving hydropower, for example, could benefit salmon species if less water is used.)

The Power of Water

Most of the electricity in the Northwest is produced by hydropower. You can use a pinwheel to illustrate that falling water contains energy. Have students hold a pinwheel under running water. What happens? (The pinwheel spins.) What happens when the water pressure is increased? (The pinwheel spins faster.) Decreased? (It spins slower.) What conclusions can the students reach about water pressure and energy production? As an extension, discuss wind as an energy source and have students demonstrate this with their pinwheels as well.

Create a Habitat

Discuss the meaning of the term *habitat.* (It means home.) Ask students to describe their homes. Then explain that wildlife habitat must include elements that animals need to survive. What do animals need to survive? (Shelter, food, water, a place to rear their young and gather food.) Have students choose a wildlife species and design a home for it that contains these requirements. As an extension, ask students to consider which other animals might benefit from the same habitat elements. (For example, if students design a home suitable for a duck, fish and frogs would also benefit from that wetland area.)

About the Authors

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For More Information

To learn more about the Interior Columbia Basin Ecosystem Management Project (ICBEMP), visit the project's homepage at http://www.icbemp.gov or write to Interior Columbia Basin Ecosystem Management Project, 304 North 8th St., Rm. 250, Boise, ID 83702; or 112 E. Poplar St., Walla Walla, WA 99362.

Resources

Arno, S.F., and Hammerly, R.P. (1977). *Trees of the West.* Seattle: The Mountaineers.

Barbour, M.G., and Billings, W.D. (1988). *North American Terrestrial Vegetation.* New York: Cambridge University Press.

Benyus, J.M. (1989). *The Field Guide to Wildlife Habitats of the Western United States.* New York: Simon and Schuster.

Clark, R. (1995). *River of the West: Stories from the Columbia.* New York: Harper Collins West.

Hironaka, M., Fosberg M.A., and Winward, A.H. (1982). *Sagebrush-Grass Habitat Types of Southern Idaho.* Moscow: University of Idaho.

Nehlsen,W., Williams, J.E., and Lichatowich, J.A. (1991). Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. *Fisheries, 16*(2), 4–21.

Rosenberry, M., et.al. (1982). *The Class Project.* Washington, DC: National Wildlife Federation.

Williams, T. (1997, March-April). Killer weeds. *Audubon Magazine,* pp. 24–31.

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Northwest Passages

The Interior Columbia River Basin

Department of the Interior, Bureau of Land Management

Artwork and associated research by Shelly Fischman

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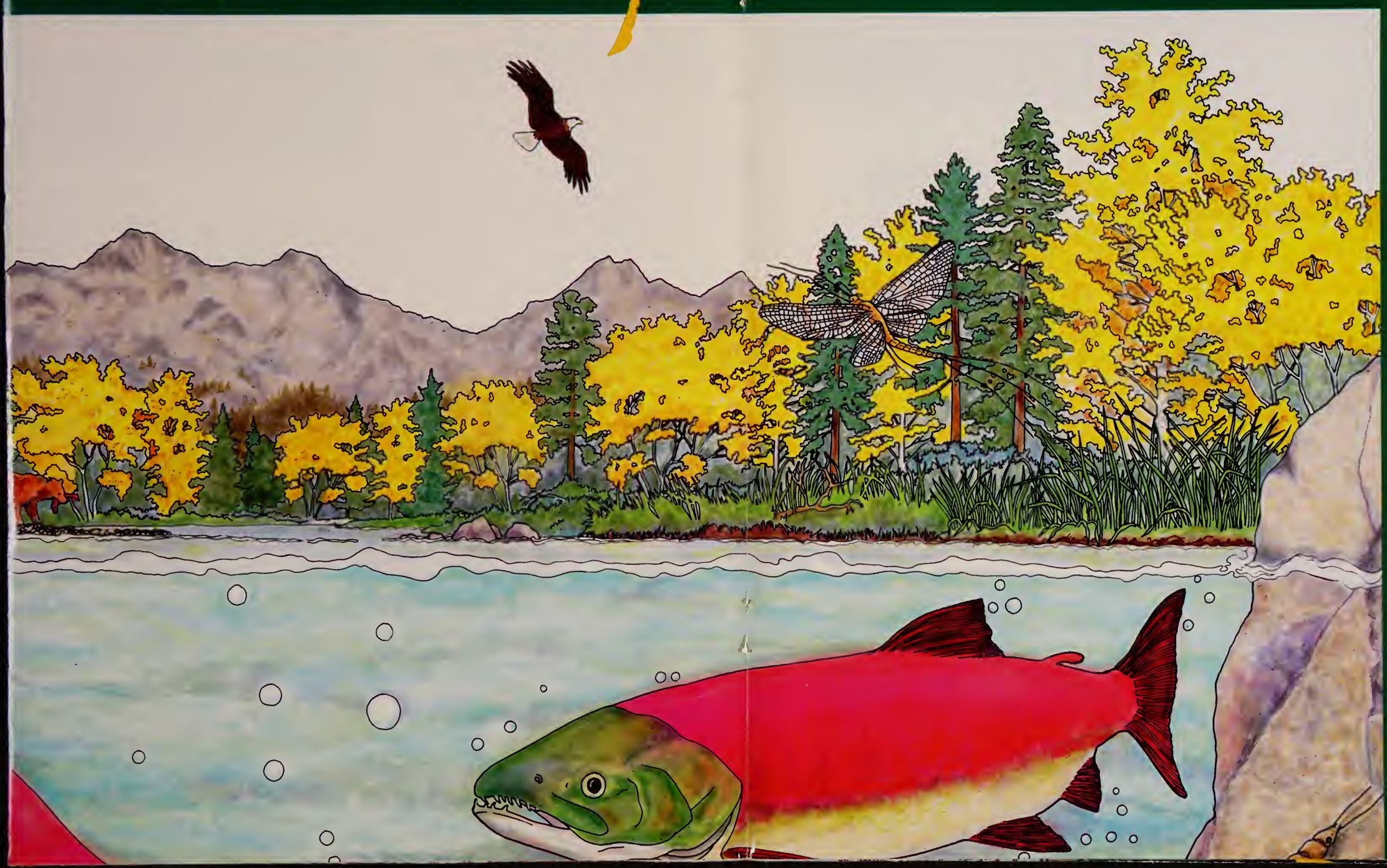

Department of the Interior, Bureau of Land Management

The Interior Colu

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NORTHWEST PASSAGES

The Interior Columbia River Basin

SCIENCE & CHILDREN

Foldout Front

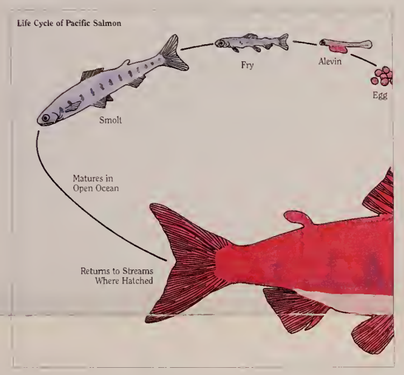
Sockeye salmon return to spawn in clear mountain streams up to 1,440 km from the ocean. See if your students can describe the components of the healthy stream habitat on the front of this foldout (clear mountain water, undercut banks, gravel beds for spawning, overhanging trees to shade and cool the water, woody debris in the stream to provide fish shelter, insects for fish to eat —although anadromous fish returning to spawn do not eat during their upstream journey).

Four additional ecosystem types found in the Interior Columbia River Basin are depicted in the streambed. From left to right, they are
- the Basin and Range (the Harney Basin in southeastern Oregon);
- the rolling, fertile Palouse Hills, part of the Columbia Plateau;
- the Snake River Uplands, a floodplain;
- and the Snake River Canyon.

A Salmon's Life: An Incredible Journey

Salmon make an incredible journey downstream from the fresh water where they are born, to the ocean, and then back upstream again as adults, finding the exact location where they began several years earlier.

Salmon lay their eggs in many of the streams and rivers of the Columbia Basin. Depending on the species, a female salmon will lay anywhere from 1,500 to 7,000 eggs in a nest or *redd* she has created by making a shallow depression in the stream bottom. The male fertilizes the eggs and then both fish push gravel over them to protect them.



Young fish or *alevins* hatch in late winter or early spring, looking more like worms than fish. These tiny fish depend on a yolk sac to provide them with nourishment until they are mobile enough to wiggle out of the gravel and find their own food. At this stage, the young salmon are called *fry*. Feeding on tiny plants and animals, the fry cluster in groups and develop into *juveniles*.

When juveniles are ready to migrate to the ocean, they undergo a physiological transition from freshwater to saltwater fish. Only about 10 percent of the fry make it to this stage and are called *smolts*.

Smolts are especially vulnerable. They are frequently injured or killed by turbine blades and the extreme pressure changes experienced when passing through the turbines of dams. In addition, smolts float downstream tail-first and depend on the river's current to flush them to the ocean quickly. The slack water created behind the dams is very difficult for the young fish to negotiate, making them vulnerable to predators. Dams also slow the migration considerably. A trip that used to take one to three weeks can now take one to three months, depending on the beginning point of the trip. The smolts have limited energy stored in their bodies and may run out before they are able to reach the ocean. Up to 90 percent of the salmon hatched never reach the ocean.

The smolts that complete the journey downstream spend several weeks in estuaries where the river meets the ocean, feeding on small fish and shrimp. Eventually, they disappear into the ocean where they grow to adulthood.

After two to five years, the adult salmon are ready to migrate upriver to spawn in the streams where they were hatched. It is believed that salmon are guided to the rivers by currents, stars, and the Earth's magnetic force. Once in the river, the fish find their home streams by scent.

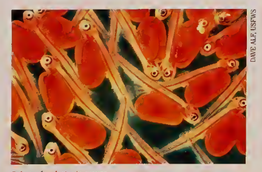
The journey upriver is a difficult one. Salmon do not eat during this time, but live on fat stored in their body. They may travel as far as 1,440 km in fresh water to their spawning grounds. Obstacles encountered upstream are many and varied. Dams, waterfalls, anglers, bears, uncertain stream conditions, and habitat degradation are among the most common challenges for the salmon in the Columbia River Basin ecosystem.


DAVID SAGES

Salmon eggs.


DAVID SAGES

Hatching salmon.


DAVID SAGES

Salmon fry cluster in groups.


DAVID SAGES

Smolt development. Only 10 percent of fry will make it to this stage.


DAVID SAGES

Kokanee salmon spawning in the North Fork of the Payette River, Idaho.

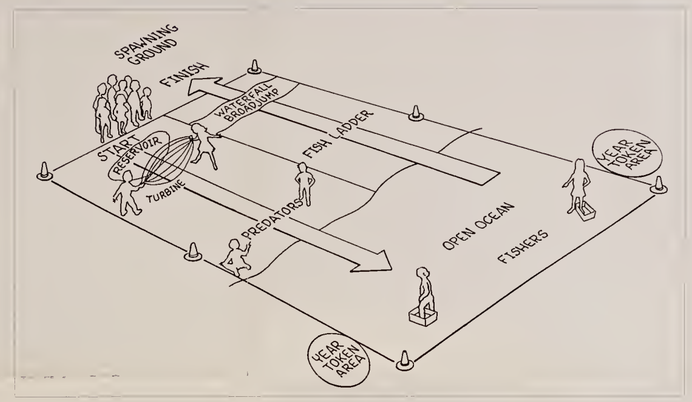
Activity 1

Hooks and Ladders

After your students become familiar with the life cycle of the salmon, try this activity to help students understand the stages in a salmon's life cycle and discover some of the challenges they face.

Materials and Setup

For this activity, you will need
- a jump rope (3.0–4.5 m long, to simulate turbines);
- approximately 150 m brightly colored nylon rope to mark boundaries (masking tape can be used if the activity is conducted indoors, or six traffic cones can be used outdoors);
- two cardboard boxes (about 30x45x35 cm);
- 100 tokens (index cards, poker chips, or other small items);
- and a large playing field (30x15 m) to simulate the salmon's habitat, as shown in the illustration.



Begin by reviewing with your students the definition of an *anadromous fish* (anadromous fish migrate from the ocean [salt water] up rivers and streams [fresh water] to spawn). What types of anadromous fish are there in the Interior Columbia River Basin? (salmon and steelhead trout) What are the major stages a salmon will go through in its lifetime?

Take students to the playing field (see illustration). Explain the location of the river (downstream and upstream) and the ocean (the end of the field). Point out the waterfall (the standing broad jump) at the top of the upstream side. In this habitat, students will simulate the life of a salmon.

Explain and assign roles (see below), keeping in mind that this is a very physical activity.

Student Roles

This activity is designed for a group of 25–30 students. If your group is larger or smaller, adjust the number of smolts/salmon.

The roles for the activity include
- two students to run the turbine in the hydroelectric dam (turn the jump rope as the salmon smolts run through it);
- two predators, usually gulls, on the downstream river. The predators will try to tag the smolts as they travel down river. (The students will want to run, but remind students that smolts float tail-first downstream. You may want to slow the students down.);
- two anglers in the ocean in boats (with one foot in a box). (The anglers will try to tag the salmon as they run back and forth across the width of the playing field. The anglers must keep one foot in the box at all times.);
- one hungry bear at the top of the waterfall waiting to tag the weary salmon coming upstream;
- and 15–20 (or more) salmon smolts.

Activity Instructions

The smolts' objective is to survive all life's challenges so they can return to the spawning ground. They will die if the blade (rope) hits them as they go through the turbine or if they are captured by any of the predators (the gulls, the anglers, or the bear) along the way.

Once in the ocean, the salmon need to be three years old before they try to migrate upstream, so they must gather three food tokens by running back and forth from one end of the ocean to the other. As they enter the upstream river, they must successfully climb the "fish ladder" without falling.

The fish ladder is "built" during the course of the activity. As smolts or salmon die, they form a line on their hands and knees along the center of the playing field between the upstream and downstream sides of the river. The line should begin about two-thirds of the way up the river. Salmon coming upriver must "leapfrog" over each "rung" (student). If they fall down, they must start from the bottom again, continuing to try until they make it to the top.

Once the salmon complete the fish ladder, they must jump (standing broad jump) the waterfall at the top of the river and avoid the bear waiting there. If they do all that, they will survive to spawn.

Follow-Up Discussion

When the activity is finished, discuss the following questions with students:
- How many salmon survived?
- How did the students cope with the challenges during the journey?
- Was the journey difficult? Easy?
- With the number of salmon that survived in this simulation, what would be the chances of long-term survival for this population?

Extensions

Set up the activity as usual, but eliminate the dam (jump rope) and the fish ladder (leapfrog). Tell students they are going back in time to the early 1930s. Play the game and record the number of survivors for later discussion.

Before playing the game for a second time, put the dam in place and assign some students to be squawfish. The squawfish should "trap" the young fish behind the dam by trying to prevent them from going through the dam. The squawfish tag the salmon in the confined space for 15 seconds before they are released to go through the dam. Also, the young fish cannot touch each other or they will die. Record the number of salmon that survive the game this time.

Compare the numbers that were recorded. What differences do students find in the survival rates of the salmon with and without the dams and the fish ladder?

Activity 2

The Grizzly Bear: A Debate

A symbol of wildlands—and one of the largest North American land mammals—the grizzly bear is a threatened species under the Endangered Species Act. Confined to only two percent of their original range in the lower 48 states, grizzlies need large blocks of diverse wildlands to thrive. Some of the most suitable habitat for grizzly bears is in the mountainous western Montana and central Idaho portions of the Interior Columbia River Basin.

Not everyone agrees, however, that grizzly bears should be reintroduced into their former ranges. Arguments for reintroduction include a belief that the top predator should be included in the wilderness ecosystem to keep populations of other animals in check. The bears were there before humans and should be allowed to reoccupy some of their former range. Arguments against reintroduction include concerns about the safety of livestock and humans, as well as concerns about restrictions on land use that may accompany a reintroduction.

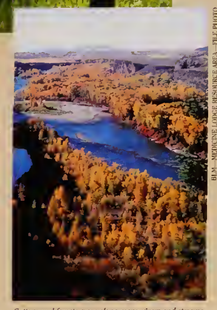
Divide the class into two groups, one that supports reintroducing grizzly bears and one that does not. Have each group brainstorm a list of facts and statements that support their arguments. Hold a class debate or invite other classes to observe and then vote on the decision. Analyze the vote in a class discussion. What persuaded the students to vote as they did? As an extension, students could debate the reintroduction of other animals, such as gray wolves and black-footed ferrets (western United States), red wolves (eastern United States), or the California condor (southwestern United States).


NORMA FARON/NATIONAL GEOGRAPHIC IMAGE COLLECTION

Bears require large blocks of wild habitat.


KAREN RICE, BLM

A healthy cottonwood forest. The understory is silverberry.


BLM, MONUMENT, LOWER SNAKE RIVER FALLS AREA — DAVE FIKKEN

Cottonwood forests grow along many rivers and streams in the West. They are part of a dynamic system that depends on periodic flooding.

Flooding Helps Cottonwood Trees

One of the most diverse and beautiful ecosystems in the state of Idaho is found in the river corridor where the South Fork and Henry's Fork of the Snake River merge, about 32 km outside of Idaho Falls. Found here is the largest cottonwood forest in the western United States. The area attracts a variety of wildlife populations including more than half of Idaho's bald eagles, a growing population of peregrine falcons, trumpeter swans, and 126 species of migratory birds (about 75 percent of which are neotropical, migrating from Central and South America each year). The area also attracts moose, elk, deer, mountain lions, and one of the largest native cutthroat trout populations outside of Yellowstone National Park.

Cottonwood trees are found throughout the western United States and are important to riparian ecosystems. They tend to grow close to the water, providing shade that cools the water to temperatures required by native fish. Tree limbs and dead trees provide protective habitat areas for young fish.

Cottonwood trees evolved on dynamic river systems that flood periodically. Floods tear down riverbanks and carry sediment downstream to form new gravel bars. Cottonwood seeds need this fresh gravel, which provides a moist, sunny environment on which to grow. New cottonwoods grow in new areas with fresh gravel bars, while old cottonwoods are replaced by juniper and sagebrush. Cottonwood forests are therefore part of a dynamic ecosystem dependent on natural flooding.

Recent changes in stream structures (dams, for example) have changed the dynamic nature of many streams, threatening the natural regeneration of the cottonwood forest. The Idaho floods in 1996, however, provided a tremendous volume of water that created large gravel bars on which cottonwood seedlings could sprout. Now, hundreds of seedlings are thriving, ensuring healthy cottonwood populations in the area for years to come.

Lodgepole Pine Forests

Lodgepole pine is the third most abundant western tree after Douglas fir and ponderosa pine. It was named by explorers Meriwether Lewis and William Clark during their historic 1804–1806 journey, when they observed Native American Indians using the straight, slender poles for their lodges or tepees. Today, lodgepole pine is a principal source of poles for log houses as well as posts.

Lodgepole pine forests are found in five of the seven states in the Interior Columbia River Basin. They cover about 80 percent of the forested land in the northern and central Rocky Mountains on the lower reaches of the subalpine fir zone and within the Douglas fir stands. They may also be found in the salt spray zone of the Pacific Coast ranging from sea level to an elevation of 2,400 m.

To understand a lodgepole forest, stand back and look at it from a distance. Foresters describe the tall, thin, dense forests as "dog-hair" stands. Lower branches die out with the shade and leave the trunk with only a topknot of live branches. Inside the stand, shade-loving seedlings thrive—Douglas fir, Engleman spruce, or subalpine fir.

Lodgepole pines are especially adapted to fire. Some of the cones are sealed by a resin that melts when heated by a forest fire. Cone scales open and seeds fall onto the bare ground that is rich with nutrients in the ash. Exposed to the sky, which supplies rain and sun, the seeds have perfect conditions for germination and growth. Because post-fire seedling establishment is often very successful, the "dog-hair" stands appear again. If there are no fires and conditions are right, the lodgepole will die out, leaving behind the spruce and fir community. Pure stands of lodgepole may persist if the site is too dry, moist, steep, or fire-prone for spruce and fir.

Lodgepole pines are especially appealing to the mountain pine beetle. When the larvae hatch, they girdle the tree as they eat their way around its circumference. Although this is destructive, it creates a habitat for other forest dwellers. Dead trees or snags may stand for more than 20 years and provide perches for hawks and cavities for owls, chickadees, and squirrels. Downed trees provide a haven for red-backed voles, toads, salamanders, western garter snakes, and rubber boas.

Live tree stands are home to a variety of insect and seed-eating birds such as yellow-rumped warblers, ruby-crowned kinglets, mountain and black-capped chickadees, white- and red-breasted nuthatches, pine siskins, western and mountain bluebirds, Townsend solitaires, and blue grouse. Mule deer and elk use the stands for cover and browse on lichen.

As with many ecosystems, lodgepole pine forests have been drastically modified by aggressive fire suppression. As more fires are curtailed and acres of trees die from beetle kill, fuels accumulate, setting the stage for larger and more severe fires.


LARRY PRESNER/BLM

Elk in a lodgepole pine stand in Idaho.


BLM

Lodgepole pines are characterized by their long, straight poles.

NORTHWEST PASSAGES

The Interior Columbia River Basin

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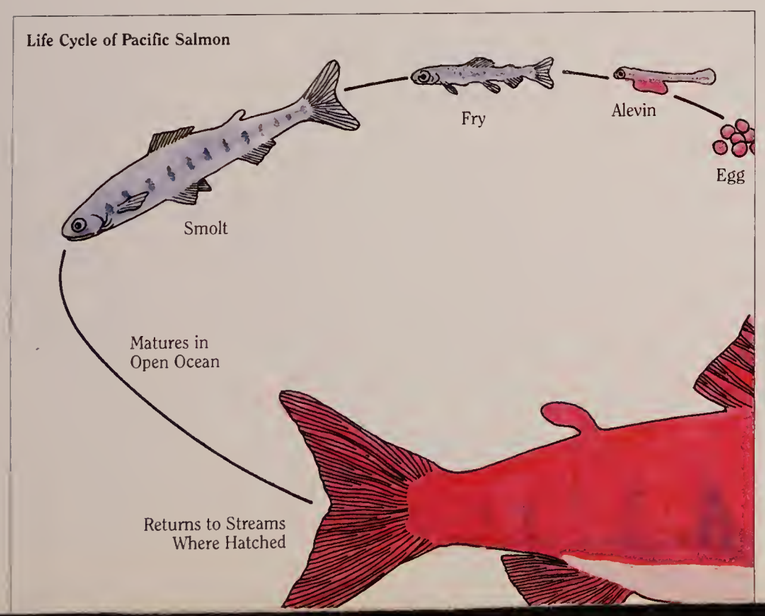

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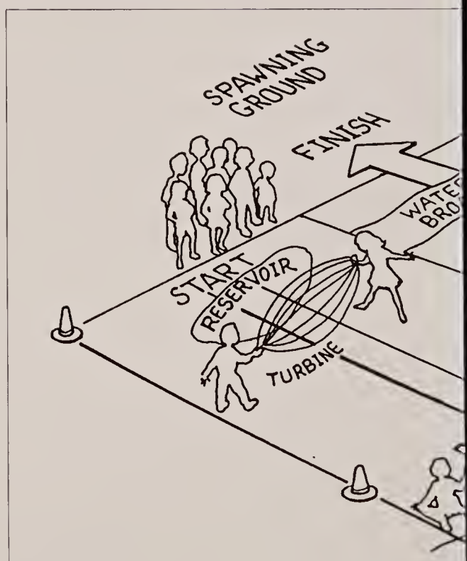

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SCIENCE & CHILDREN

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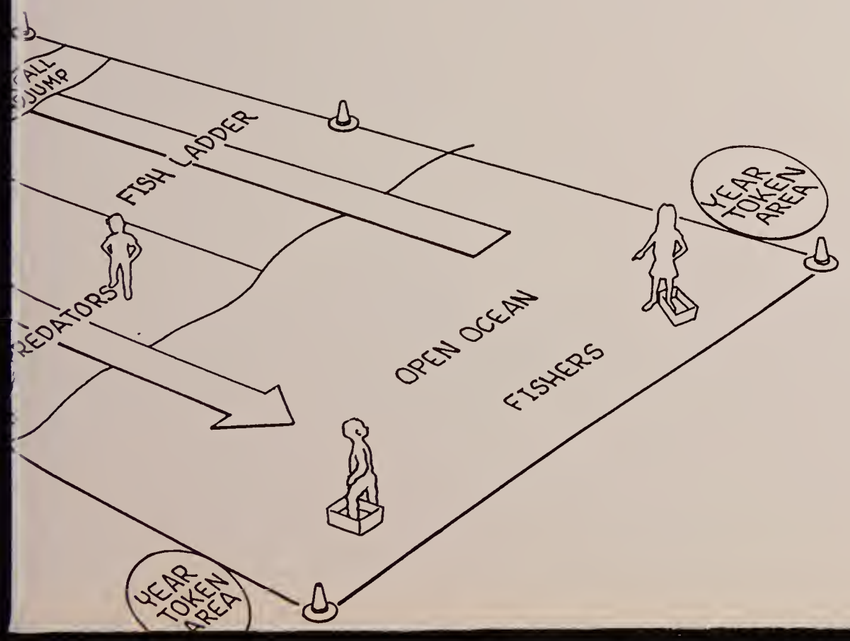

KAREN RICE, BLM

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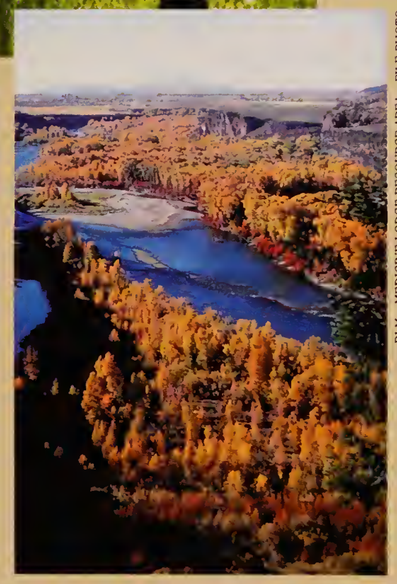

BLM—MEDICINE LODGE RESOURCE AREA—FILE PHOTO

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DAVE ALF, USFWS

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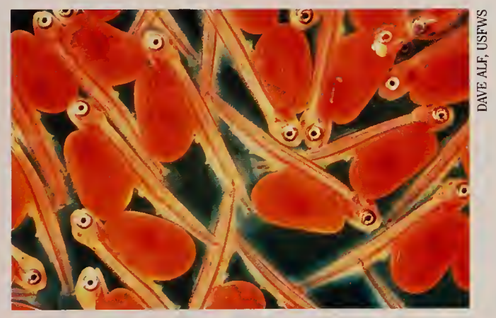

DAVE ALF, USFWS

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USFWS PHOTO

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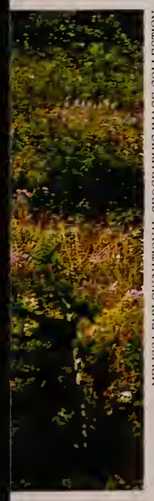
l, but eliminate the dam (jump rope) and the fish ladder (leapfrog).
g back in time to the early 1930s. Play the game and record the number
ssion.
e for a second time, put the dam in place and assign some students to be
should "trap" the young fish behind the dam by trying to prevent them
ım. The squawfish tag the salmon in the confined space for 15 seconds
go through the dam. Also, the young fish cannot touch each other or they
r of salmon that survive the game this time.
that were recorded. What differences do students find in the survival
nd without the dams and the fish ladder?

A Debate

d one of the largest North American land mammals—the grizzly bear is a he Endangered Species Act. Confined to only two percent of their original range zlies need large blocks of diverse wildlands to thrive. Some of the most suitable in the mountainous western Montana and central Idaho portions of the Interior

owever, that grizzly bears should be reintroduced into their former ranges. ion include a belief that the top predator should be included in the wilderness ions of other animals in check. The bears were there before humans and should ne of their former range. Arguments against reintroduction include concerns about the safety of livestock and humans, as well as concerns about restrictions on land use that may accompany a reintroduction.

Divide the class into two groups, one that supports reintroducing grizzly bears and one that does not. Have each group brainstorm a list of facts and statements that support their arguments. Hold a class debate or invite other classes to observe and then vote on the decision. Analyze the vote in a class discussion. What persuaded the students to vote as they did? As an extension, students could debate the reintroduction of other animals, such as gray wolves and black-footed ferrets (western United States), red wolves (eastern United States), or the California condor (southwestern United States).



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Lodgepole Pine Forests

Lodgepole pine is the third most abundant western tree after Douglas fir and ponderosa pine. It was named by explorers Meriwether Lewis and William Clark during their historic 1804–1806 journey, when they observed Native American Indians using the straight, slender poles for their lodges or tepees. Today, lodgepole pine is a principal source of poles for log houses as well as posts.

Lodgepole pine forests are found in five of the seven states in the Interior Columbia River Basin. They cover about 80 percent of the forested land in the northern and central Rocky Mountains on the lower reaches of the subalpine fir zone and within the Douglas fir stands. They may also be found in the salt spray zone of the Pacific Coast ranging from sea level to an elevation of 2,400 m.

To understand a lodgepole forest, stand back and look at it from a distance. Foresters describe the tall, thin, dense forests as "dog-hair" stands. Lower branches die out with the shade and leave the trunk with only a topknot of live branches. Inside the stand, shade-loving seedlings thrive—Douglas fir, Engleman spruce, or subalpine fir.

Lodgepole pines are especially adapted to fire. Some of the cones are sealed by a resin that melts when heated by a forest fire. Cone scales open and seeds fall onto the bare ground that is rich with nutrients in the ash. Exposed to the sky, which supplies rain and sun, the seeds have perfect conditions for germination and growth. Because post-fire seedling establishment is often very successful, the "dog-hair" stands appear again. If there are no fires and conditions are right, the lodgepole will die out, leaving behind the spruce and fir community. Pure stands of lodgepole may persist if the site is too dry, moist, steep, or fire-prone for spruce and fir.

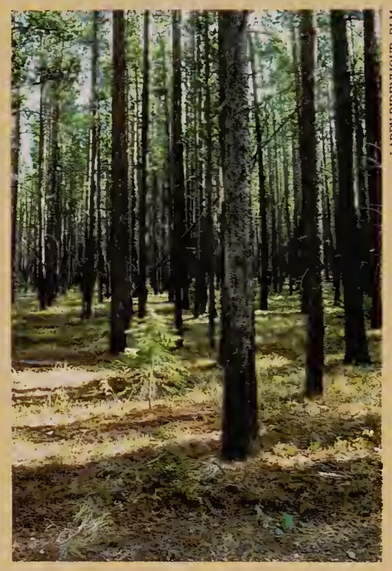
Lodgepole pines are especially appealing to the mountain pine beetle. When the larvae hatch, they girdle the tree as they eat their way around its circumference. Although this is destructive, it creates a habitat for other forest dwellers. Dead trees or snags may stand for more than 20 years and provide perches for hawks and cavities for owls, chickadees, and squirrels. Downed trees provide a haven for red-backed voles, toads, salamanders, western garter snakes, and rubber boas.

Live tree stands are home to a variety of insect and seed-eating birds such as yellow-rumped warblers, ruby-crowned kinglets, mountain and black-capped chickadees, white- and red-breasted nuthatches, pine siskins, western and mountain bluebirds, Townsend solitaires, and blue grouse. Mule deer and elk use the stands for cover and browse on lichen.

As with many ecosystems, lodgepole pine forests have been drastically modified by aggressive fire suppression. As more fires are curtailed and acres of trees die from beetle kill, fuels accumulate, setting the stage for larger and more severe fires.

LARRY RIDENHOUR, BLM

Elk in a lodgepole pine stand in Idaho.



LARRY RIDENHOUR, BLM

Lodgepole pines are characterized by their long, straight poles.